



Global Interoperability Program (GIP)

Introducing Shared Software Infrastructure into the Climate Modeling Curriculum

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Overview

Next-generation weather and climate models put strong demands on computing capabilities, transparent software designs with exchangeable components, self-explanatory descriptions of data and models, online gateways and portals for data exchanges, and shared online workspaces for both tight and loose science collaborations. Such challenges demand a highly versatile and interdisciplinary workforce. In 2010 this GIP project trained graduate students how to design, evaluate and develop the fluid dynamics component of climate models and how to utilize shared software infrastructure tools that aid the model development.

Achievements and Highlights

- New hands-on course 'The Art of Climate Modeling' has been taught in the Fall 2010 at the University of Michigan
- Training of 11 graduate students in (1) climate modeling, (2) software infrastructure for the atmospheric sciences, (3) design and use of federal weather and climate models (with focus on NCAR's Community Earth System Model CESM))
- Specification of requirements for shared workspaces
- Development of a prototype shared workspace on the basis on 'Google Sites': <https://sites.google.com/site/theartofclimatemodeling/> that now serves as the template for the GIP development of shared workspaces
- In-class introductions to the Earth System Grid (ESG) and Earth System Modeling Framework (ESMF) in collaborations with ESG and ESMF developers

Outcomes of the 'Art of Climate Modeling' Course:

The class was designed as a hands-on project-driven class that was based on lectures, in-class journal paper discussions, modeling projects, and the exploration of software tools in the climate modeling community. After the completion of the course students considered General Circulation Models (GCMs) no longer a black box. The students were enabled to make intelligent decisions on how to develop and use GCMs for their scientific research and what the limitations of GCMs are. The students were exposed to real world GCMs developed at NCAR,

NCAR's high-performance computing architectures, and standard software practices in atmospheric science. In addition, they developed a broad understanding of the literature and technical model documentations.

The science focus of the course was put on the so-called dynamical cores of GCMs that describes the fluid dynamics component of each weather and climate model. The design decisions for building dynamical cores of GCMs incorporate the choice of the equation set, numerical methods, computational grids, accuracy, conservation properties and diffusion mechanisms. The course reviewed these choices and provided an in-depth look at their pros and cons. In addition, the design decisions for building Earth System Models incorporate much more, such as the coupling strategy between the components of the climate system like the ocean and atmosphere. Climate models and their individual components (e.g. the dynamical cores) also need to be compared to other models and observations to assess their performance. The latter aspects demand the efficient use of computational tools and shared workspaces. The course developed a prototype shared workspace on the basis of 'Google Sites' that now informs the shared workspace developments in GIP. A screenshot of this site is shown on the next page.

The course introduced the concepts of ESG, ESMF and visualization tools for NetCDF climate model data. In particular, guest lecturer Dr. Jerry Potter (ESG consultant, former scientist at the Lawrence Livermore National Laboratory) gave hands-on guidance on how to use and navigate ESG.

Links:

<https://sites.google.com/site/theartofclimatemodeling/>

This shared workspace includes pointers to the class syllabus, lecture notes, journal articles, team members, results of the hands-on projects and other resources. The link is publicly accessible.

Impact:

The University of Michigan serves as a key partner in GIP. We have been an educator for the future generation of atmospheric modelers by introducing a new graduate-level climate modeling course with special emphasis on computational aspects. In addition, we have been a communicator who provided feedback to GIP on the ease of use, quality, possible enhancements, and usability of shared modeling infrastructure and shared workspaces that are a key element of GIP.

For more information:

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Screenshot of the shared workspace developed in the course ‘Art of Climate Modeling’:

Google sites The Art of Climate Modeling (AOSS 605) Private to me + 23 more 2 minutes ago

Create page Edit page More actions

The Art of Climate Modeling

Search this site

Navigation

The Art of Climate Modeling (AOSS 605)

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Class news

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Term Projects: Definition

- Term project Colin
- Term project Evan
- Term project James
- Term project Kevin
- Term project Peter
- Term project Ran
- Term project Richard
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The Team

Time Tracker

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Sitemap

Model Intercomparison

Overview

Idealized GCM experiments

Dynamical core test cases
Aqua-planet experiments

Class material

- Syllabus
- GCM model documentation
- Lectures
- Journal articles
- Blogs and other resources

Project 1: Derivation of idealized initial conditions for GCMs

- Description
- Results

Project 2: Test the initial conditions with CESM 1

- Description
- Results

Project 3: Numerical methods and advection schemes

- Description
- Results

Project 4: Learn about the diffusion properties and filters in the CESM dycores

- Description
- Results

Join Our Discussion

The Art of Climate Modeling (AOSS 605)

Tip: [How to replace these images with your own.](#)

Snapshots from Project 3:

Colin Zarzycki from Team 'limited semi-Lagrangian methods' transported a tracer in the form of a Gaussian hill with five different advection schemes and visualized the 1, 2 and linf error norms after 5 rotations in this plot. See the full discussion on the page [Project 3 Colin](#).

Snapshots from Project 2:

Kevin Reed from Team FV perturbed the steady-state initial conditions from project 1 at the equator and thereby triggered breaking baroclinic waves. They are symmetric about the equator. The plot shows latitude-longitude cross sections of the evolving fields just after the waves started breaking (day 12). See the full discussion on the page [Project 2 Kevin](#).

Tip: [How to insert objects like these in your page.](#)

Messages

Term project presentations Let's take a look at your accomplishments. The term projects cover a wide area of atmospheric modeling and promise to be very interesting. Congratulations on your accomplishments in such ...
Posted Dec 10, 2010 1:57 PM by Christiane Jablonowski

Review of the term projects On Monday 11/8 we will review the progress you made on your term projects. Come prepared and present a concise plan of your project. The second review will be ...
Posted Nov 7, 2010 7:46 PM by Christiane Jablonowski

Cyberinfrastructure and Climate Modeling Christiane will present the connection between cyberinfrastructure and climate modeling at the upcoming Cyberinfrastructure Day (11/3) at the University of Michigan. Find out about it at <http://orci.research...>
Posted Oct 15, 2010 10:01 AM by Christiane Jablonowski

Time for term projects It's time to finalize the plans for the term projects. Please start building up your term project web page.
Posted Oct 14, 2010 6:54 PM by Christiane Jablonowski

Special AOSS seminar on Tuesday 10/19 On Tuesday (10/19, 2-3pm, SRB 2246) Peter Lauritzen from the National Center for Atmospheric Research (NCAR) will be giving an AOSS seminar on semi-Lagrangian finite-volume advection ...
Posted Oct 14, 2010 6:31 PM by Christiane Jablonowski

Showing posts 1 - 5 of 12. [View more »](#)

Who?	Description	Due Date	Complete
James	Paper review 4	October 29, 2010	✓
All	Discussion of term projects: First progress report	November 8, 2010	
Rich	Paper review 5	November 8, 2010	

Showing 3 items from page [To-Dos](#) sorted by Due Date, Who?, Complete. [View more »](#)